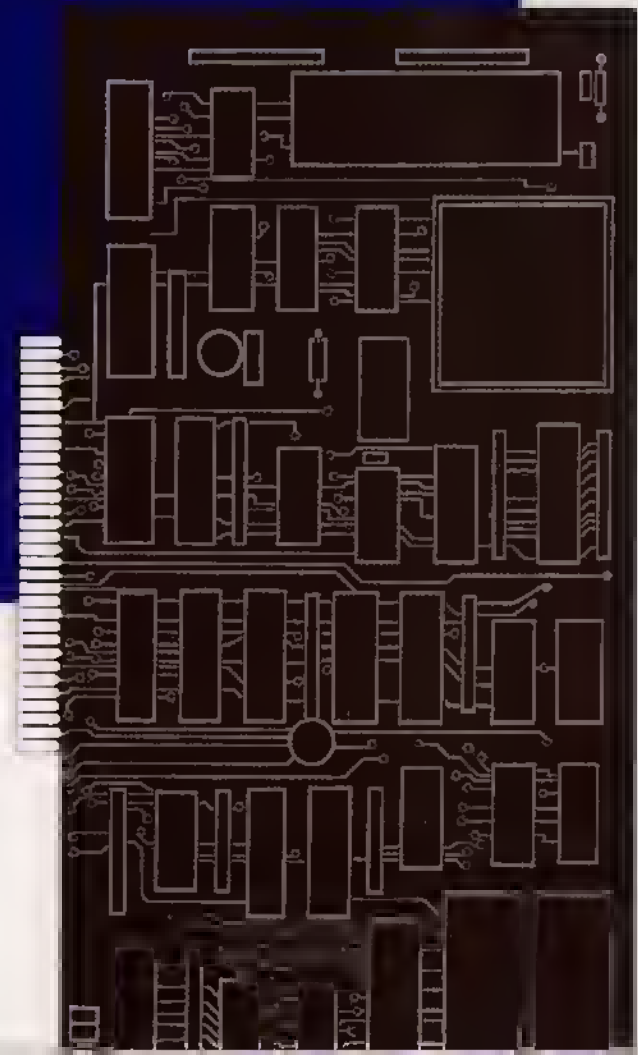


# A2320

## Display Enhancer Board



 **Commodore®**  
**AMIGA®**

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# **A2320**

## **Display Enhancer Board**

### **User's Manual**

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**NOTICE:** This device complies with Part 15 of the FCC Rules and Standard C108.8-M1983 of the Canadian Standards Association Regulations. Operation is subject to the two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received including interference that may cause undesired operation. If you suspect this device is causing interference, you can test this device by turning it off and on. If this device does cause interference, the user is encouraged to correct the interference by one of the following means:

- Reorient the receiving antenna or AC plug.
- Change the relative positions of the computer with respect to the receiver.
- Plug the computer into a different outlet so the computer and receiver are on different branch circuits.

**CAUTION:** Only peripherals with shielded-ground cables (computer input-output devices, terminals, printers, etc.) certified to comply with Class B limits can be attached to this device. Operation with non-certified peripherals may result in communications interference. Changes or modifications to this device not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Your house AC wall receptacle must be a three-pronged type (AC ground). If it is not, contact an electrician to install the proper receptacle. If a multi-connector box is used to connect the computer and peripherals to AC, the ground must be common to all units.

If necessary, the user should consult the dealer or an experienced radio-television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402. Stock No. 004-000-00345-4.

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# 1.

## Introduction

The A2320 Display Enhancer board for the Commodore Amiga 2000 family of personal computers provides an alternate video display output that yields an image with no flicker or visible scan lines in interlaced or non-interlaced Amiga graphics modes. The solid, flicker-free output of the A2320 is ideal for Amiga applications requiring the crispest, most professional high-resolution color display possible.

The A2320 board is intended to be compatible with existing software and internal Amiga plug-in boards (except other boards that occupy the Video slot), as well as the new ECS 'Productivity' and 'Superhires' modes available under AmigaDOS™ 2.0. The board can also function with many external genlocks, providing flicker-free reference display of Amiga graphics during video work. And the A2320 Display Enhancer significantly augments the graphics presentation potential of the Amiga for business applications of the Amiga 2000.

### A2320 Display Enhancer Main Features

- Employs de-interlacing in Amiga interlaced display modes to remove flicker and visible scan lines with full overscan support for both NTSC and PAL Amiga modes. This is achieved by a custom gate array and 1-Mbit CMOS digital video field memories.
- Employs scan-doubling in Amiga non-interlaced display modes to remove visible scan lines WITHOUT motion artifacts.
- Severe overscan support.
- Compatible with both NTSC and PAL Amiga video formats.
- Supports the new ECS display modes, such as Productivity mode, under AmigaDOS 2.0. The A2320 Display Enhancer board automatically detects Productivity mode and responds accordingly (see Chapter 4.)

- A mode switch is provided to allow bypassing of the de-interlaced or scan-doubled video for output of the original Amiga video to the multiscan monitor. This is used to display the ECS Superhires mode (1280 X 200/256 or 1280 X 400/512) on the monitor.
- A2320 output is not interfered with by many external genlocks (NTSC or PAL), providing high-resolution, flicker-free display of Amiga-only RGB graphics.
- Transparent to software.
- Video output is compatible with standard multiscan (multi-sync) VGA monitors and provides a standard female DB15 VGA-style connector.
- An Amiga monitor (1084, 1084S, 1080, 2002) or external composite encoder box (A520) can remain attached to the Amiga's 23-pin RGB port, providing a standard video display.
- Fully supports the Amiga's 4096-color palette and HAM (hold-and-modify) modes.
- Plugs into the video slot of the Amiga and does not sacrifice any of the Amiga bus slots.

## 2. How to Install the A2320 Display Enhancer Board

**WARNING:** Unplug your Amiga before installing the A2320. Installing the A2320 with the power connected could cause injury to the installer and damage to the equipment.

Commodore will not be responsible for any damages caused by improper installation of the A2320. Such improper installation will void the warranties on both the A2320 and the Amiga. It is recommended that installation of internal expansion boards be handled by an Authorized Commodore Service Center.

Before beginning, make sure that the following items have been received:

- A2320 Display Enhancer Board in anti-static bag.
- plastic alignment tool
- Grounding clip (for countries that require it)
- A2320 Test/Demo disk
- A2320 User's Manual and Warranty card

If any of the above items are missing please contact the dealer from whom you purchased the A2320 Display Enhancer Board.

### NOTE:

Except where otherwise indicated, throughout this manual references to "left" and "right" should be understood to be as you face the front of the machine.

## Removing the Amiga's Cover —

Tools needed: Phillips-head screwdriver

To install the A2320, you must first make sure the Amiga is OFF. Disconnect the mouse and keyboard from the front of the Amiga,

and remove the power cord and any peripherals attached to the back of the machine. On the lower left side of the Amiga, remove the two screws that hold the metal cover to its base. Remove the corresponding screws on the right side of the Amiga. Remove the Center screw from the rear of the Amiga. Be careful to remove the correct screw as shown (see Fig. 1.)

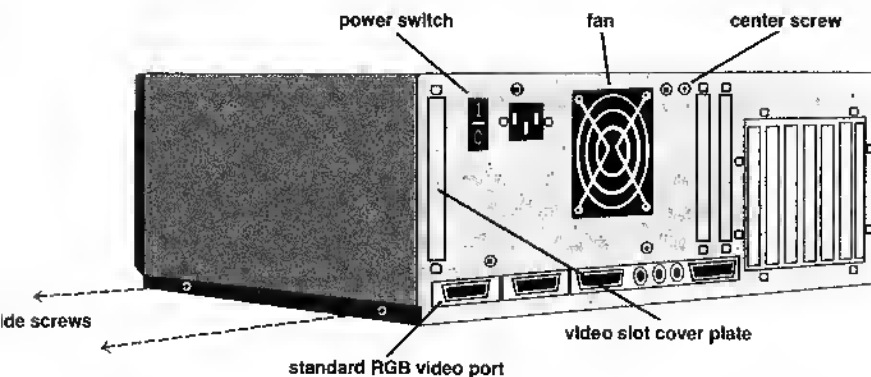


Fig. 1: A2000 — Rear View

Turn the Amiga so that you are facing the front of the machine. Grasp the cover on both sides, slide it toward you, and lift upward. If the cover gets stuck, do not force it. Look under the top of the cover toward the middle and check to see if any wires or cables are caught under the tab to which the middle screw had been attached. If anything is caught, gently untangle it, and continue to slide the cover off.

## Installing the A2320 —

Before installing the A2320, you must first determine whether your Amiga 2000 has a 2- or 4-layer motherboard. **The A2320 can ONLY be used with the 2-layer motherboard version of the Amiga 2000.** This is determined by looking at the front left-hand corner of the motherboard. You should find, on the left edge of the motherboard, a label which says "AMIGA B2000 · CR" which indicates that your Amiga does indeed have a 2-layer motherboard. (See Fig. 2.)

If you do not find this label, you can also determine whether your Amiga has the correct motherboard by looking at the Video slot on the right side of the power supply. If there are TWO 36-pin connec-

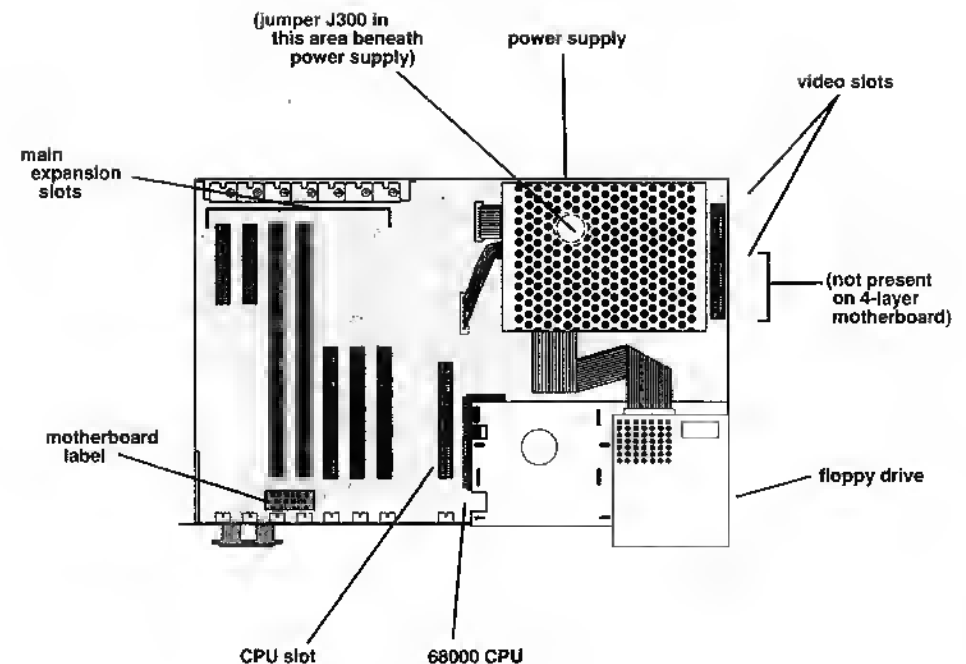
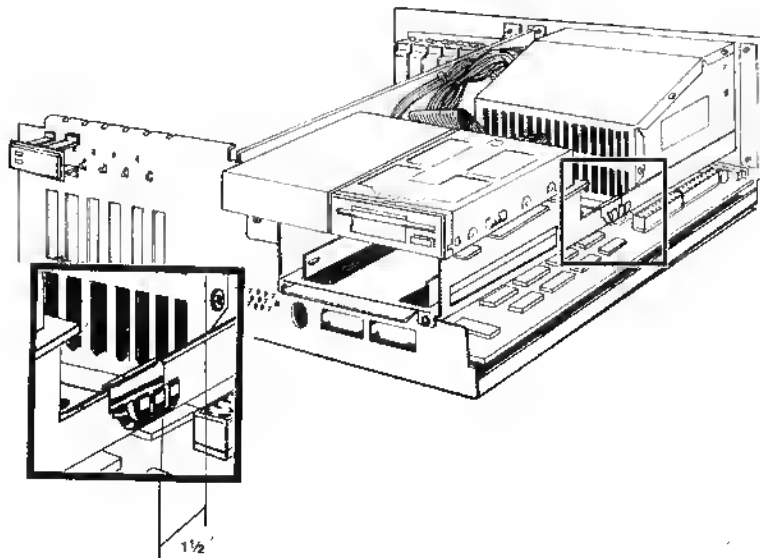


Fig. 2: A2000 — Top View

tors on the motherboard then your Amiga has a 2-layer motherboard and you may continue with the installation procedure. If there is only one 36-pin connector there you should consult an authorized Commodore service center for a replacement of your motherboard with the newer 2-layer version.

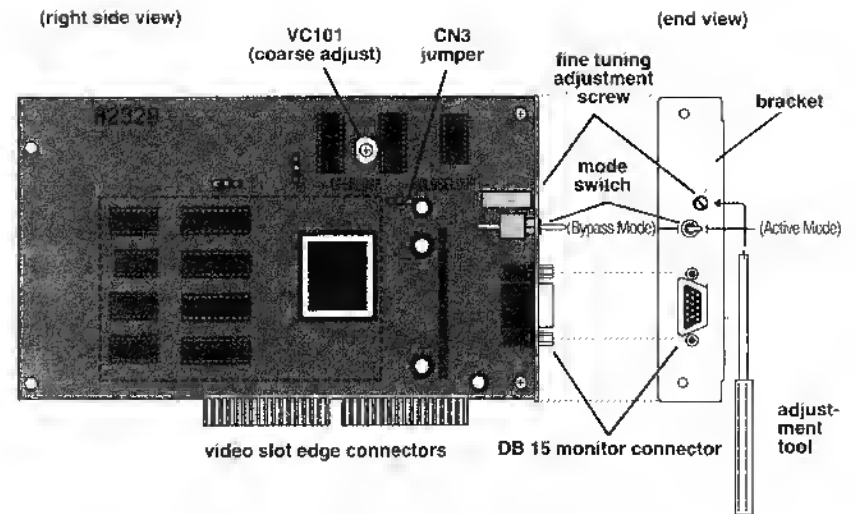
The A2320 is installed in the Video slot on the right side of the power supply. Turn the Amiga so that you face the rear panel of the computer and locate the Video slot cover plate which is just to the left of the power switch. Remove the screws that hold the metal plate in place and lift it out. Save the screws; you'll need them for installation of the A2320 board.

If a copper grounding clip, shaped like a "U", is included with your A2320, install it as follows. Measure out from the front end of the power supply 1.5 inches along the right side of the disk drive tray (as you face the front of the A2000) and slip the grounding clip over the edge of the tray such that the fingers of the clip are toward the right side of the A2000 and the open end of the clip is facing up (see Fig. 3). Note that on the back of the A2320 board there is a cut-out in the insulation sheet and a bare area on the board itself. For proper grounding, ensure that the grounding clip is touching the bare area on the board.

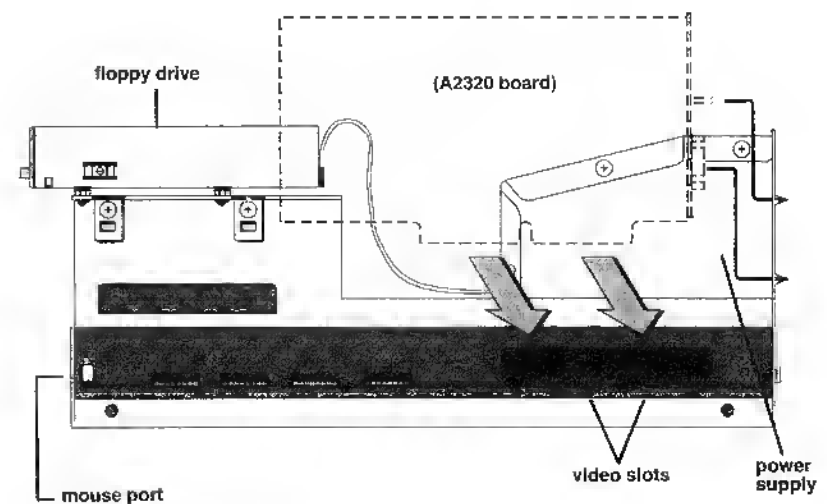


**Fig. 3: Copper Grounding Clip**

Remove the A2320 board (Fig. 4) from its protective anti-static bag and orient the board so that the bracket and connectors are toward the rear of the machine with the IC chips facing away from the power supply (see Fig. 5). Align the A2320 board above the video slot connectors with the metal bracket against the inside rear panel of the computer and the DB15 monitor connector and mode switch poking through the rear panel opening. Applying gentle pressure, insert the board into the two slots until you feel the board seat firmly.



**Fig. 4: A2320 Display Enhancer Board**



**Fig. 5: A2320 — Installation, Right side View**

When the A2320 is in place, secure it with the screws that held the cover plate in place by first inserting the lower screw through the rear panel and screwing it loosely into the thread on the metal bracket attached to the board. You may have to loosen the two mounting bracket screws that hold the metal bracket to the A2320 circuit board in order to obtain the proper fit. Gently tilt the board

left or right until the upper hole in the rear panel is aligned with the thread in the metal bracket. Insert the upper screw and tighten the upper, lower, and mounting-bracket screws.

Now that your A2320 Display Enhancer board has been installed, replace the A2000's cover and replace the five screws that you removed. Carefully re-install any removed equipment, the mouse and keyboard, any peripherals, and finally the power cord.

### **Connecting the Multiscan Monitor —**

The A2320 Display Enhancer board is compatible with standard multiscan (multiple sync-frequency or "multisync") monitors, including the Commodore 1950 Multiscan Monitor, and provides a standard female DB15 VGA-style connector for the monitor. Using a shielded cable with a DB15 male plug on one end, plug the monitor cable into the A2320's video output connector, the other end into the monitor, and tighten the screws on the cable connectors at both the computer and monitor ends. If the multiscan monitor that you are using does not provide a DB15 VGA-compatible cable, please see your local dealer to obtain an adapter that will allow your specific monitor to work with standard 15-pin VGA video boards.

## **3. Adjusting the A2320's Fine Tuning Control**

The A2320 Display Enhancer has been factory-adjusted to work with both NTSC and PAL-based Amiga A2000s (Note: NTSC is the video standard that is used throughout most of North America, Latin America and Japan. PAL is the video standard that is used throughout most of Europe). Therefore, the only adjustment that is usually necessary for a newly-installed A2320 is done with the Fine Tuning control screw ("PHASE ADJUST"). When you install the A2320 into any A2000 you may have to adjust this fine tuning control. There are actually two tuning adjustment controls, Fine and Coarse. If for some reason the Fine tuning adjustment fails to properly provide a stable video display, please see the 'Troubleshooting' chapter later in this manual.

### **Adjustment Procedure —**

To adjust the A2320's tuning controls, you must have already installed the A2320 board as described in the previous chapter and connected the multiscan monitor to the A2320's video output. Insert the A2320 Test/Demo disk, included in the shipping carton, into floppy drive DF0: and power on the monitor and then the Amiga. From the front of the machine reach around to the back of the Amiga and enable the de-interlacing/scan-doubling circuitry of the A2320 by flipping the toggle switch leftward to the "Active Mode" position. The display may look unusual and may have pixels "jittering," but it should be otherwise recognizable. Don't worry—the fine tuning adjustment will stabilize the display. If the Amiga does not boot up normally, please see the 'Troubleshooting' chapter.

After switching the A2320 into Active mode, locate the fine tuning control hole in the metal bracket just above the mode switch (see Fig. 4). Position the monitor so that while reaching around to the right rear of the Amiga with the plastic alignment tool you will be able to see the screen. After allowing the A2320 board and the Amiga to warm up for approximately five minutes, you are ready to begin the adjustment. If you have an Amiga with the Enhanced Chip Set and AmigaDOS 2.0, skip to the 'ECS and AmigaDOS 2.0' section further below.



## Standard Chipset and AmigaDOS 1.3 or earlier —

First, double-click on the A2320 Test/Demo disk icon and then on the 'A2320\_Test\_1' icon. Now insert the alignment tool straight into the fine tuning control hole and engage it in the screw slot, and slowly turn the fine tuning control clockwise or counterclockwise until all parts of the display are stable and are not jittering. This should occur in one to fifteen full turns of the fine tuning control screw. If you think that you have gone too far, turn the fine tuning control in the opposite direction. You may be able to hear a slight clicking sound as you turn the fine tuning control. This just indicates that the screw has reached the end of its travel, and you should turn the screw in the opposite direction.

When you have achieved the best image you can with the 'A2320\_Test\_1' pattern, you should temporarily push its screen to the back so you can open the second test screen. Click anywhere in the lower half of the image to bring up a title bar with depth gadgets in the upper right corner of the screen. Click on the Back gadget to bring up the Workbench screen and double-click on the 'A2320\_Test\_2' icon. Again using the alignment tool, slowly turn the fine tuning control clockwise or counterclockwise until all parts of the 'A2320\_Test\_2' display are stable and are not jittering.

Click anywhere in the lower half of the image to produce the depth gadgets and again click on the Back gadget, then the Workbench screen's Back gadget to reveal the first pattern screen, and check to be sure that the 'A2320\_Test\_1' image is still stable with your new fine tuning setting. Be sure to look closely at all the colors, lines, and patterns for both images when adjusting the fine tuning control for a sharp and stable display. When all test patterns appear satisfactory, adjustment is complete, and you can click in the upper-left corner of each image to close the screens and return to the Workbench screen.

## ECS and AmigaDOS 2.0 —

If you have the ECS chip set and AmigaDOS 2.0, then you should perform the following fine tuning adjustment procedure. Boot your machine with AmigaDOS 2.0 as you normally would from floppy or hard disk, depending on your system. Open the Workbench™ 2.0 'Prefs' drawer, and double-click on the 'WBScreen' icon. With the

mouse, select the 'Superhires' video mode and click on the 'Use' gadget. Your Amiga will then switch to the 1280 X 200/256 display mode. You should then flip the A2320 mode switch to the right (away from the fan) to put the A2320 into Bypass mode. Double-click on the A2320 Test-Demo disk icon and then on the 'A2320\_Test\_3' icon to bring up a special test pattern window on the screen.

Now insert the alignment tool straight into the fine tuning control hole and engage it in the screw slot, and slowly turn the fine tuning control clockwise or counterclockwise until all parts of the display are stable and are not jittering. This should occur in one to fifteen full turns of the fine tuning control screw. If you think that you have gone too far, turn the fine tuning control in the opposite direction. You may be able to hear a slight clicking sound as you turn the fine tuning control. This just indicates that the screw has reached the end of its travel, and you should turn the screw in the opposite direction.

When you have achieved the best image you can with the 'A2320\_Test\_3' pattern, double-click on the 'A2320\_Test\_1' icon. Flip the mode switch to Active mode and again using the alignment tool, slowly turn the fine tuning control clockwise or counterclockwise until all parts of the 'A2320\_Test\_1' pattern are stable and are not jittering. Click anywhere in the lower half of the image to bring up a title bar with the depth gadget in the upper right corner of the screen. Click on the gadget to bring up the Workbench screen, double-click on the 'A2320\_Test\_2' icon, and repeat the same adjustment procedure as with 'A2320\_Test\_1'. When it too is stable, use the depth gadget to return to the 'A2320\_Test\_1' pattern and check to make sure that it has not lost stability with the new fine tuning setting. Then return to Bypass mode and recheck the 'A2320\_Test\_3' pattern as well. Be sure to look closely at all the colors, lines, and patterns of all three images when adjusting the fine tuning control for a sharp and stable display. Once all test patterns appear satisfactory, adjustment is complete and you can return the mode switch to the Active position. Click in the upper-left corner of each test pattern to close the screens and return to the Workbench screen.

You may now click on the icons of any of the included graphic demos supplied on the A2320 Test/Demo disk and see how much better the Amiga video display appears. If you switch the mode switch on the back of the A2320 board from Active mode to the

right (Bypass mode), you can observe the normal non-enhanced Amiga video display for comparison—you'll never want to go back. Enjoy!

**NOTE:** If after attempting to adjust the fine tuning control you are unable to obtain a stable display, please refer to the 'Troubleshooting' chapter of this manual. Once you have the A2320 operating, you may need to adjust your monitor's position and size controls to center the screen on your monitor. If, over time, the display develops pixel jitter, you may have to slightly adjust the fine tuning control to make the display stable again.

## 4. Operation and Compatibility

The A2320 Display Enhancer board is capable of operation in all the graphics modes available on the Amiga. In the non-interlaced Amiga modes (i.e. 320 X 200/256 and 640 X 200/256) the A2320 Display Enhancer will automatically operate in Scan-double mode. This means that the A2320 is repeating every line to increase the raster scan rate from 15.734 KHz NTSC (15.625 KHz PAL) to 31.46 KHz NTSC (31.25 KHz PAL). In this mode of operation, the A2320 removes visible scan lines with full overscan and HAM support, making text and graphics solid and professional. Another benefit of this mode of operation is that there are no motion artifacts (i.e. shearing or ghosting effects with moving objects) which has obvious value for animation and game software which features rapid object animation.

In the interlaced Amiga modes (i.e. 320 X 400/512 and 640 X 400/512) the A2320 Display Enhancer will automatically operate in De-interlace mode. Here, the A2320 is storing the previous video field and combining it with the current incoming video field. This removes flicker and visible scan lines, still with full overscan and HAM support, again by doubling the raster scan rate. In this mode of operation you may notice some motion artifacts (i.e., ghosting effects) with fast-moving animated objects.

### ECS Compatibility—

Another Amiga display mode, which uses the ECS (Enhanced Chip Set) supported under AmigaDOS 2.0, is called 'Productivity' mode. This mode has a display of 640 X 480 with 4 colors out of a palette of 64, and a raster scan rate of 31.46 KHz. In this display mode the A2320 Display Enhancer will automatically bypass the video data to the multiscan monitor since the raster scan rate is already at 31.46 KHz and has no flicker or visible scan lines.

Still another Amiga display mode which uses the ECS under AmigaDOS 2.0 is 'Superhires' mode. This mode has a display of either

1280 X 200/256 or 1280 X 400/512, with 4 colors out of a palette of 64, and a raster scan rate of 15.734 KHz NTSC (15.625 KHz PAL). In this display mode the A2320 only samples every other pixel and may cause a distorted display, so you should set the mode switch on the back of the A2320 metal bracket to the Bypass mode (flip the toggle switch to the right, away from the fan).

If there are any other display modes that confuse the A2320 Display Enhancer, simply flip the mode switch to Bypass mode and whatever the Amiga generates will be sent to the monitor as if the A2320 were not in the system.

### **External Genlock Compatibility —**

The A2320 Display Enhancer board is compatible with many external NTSC and PAL genlocks, including the new genlock extensions supported in AmigaDOS 2.0. Compatible genlocks include Mimetix's *AmiGen*, Digital Creations' *SuperGen* and the Omicron Video 701 (NTSC) and 702 (PAL) genlocks. To use the A2320 with an external genlock, simply connect the genlock to the Amiga's 23-pin video port, as detailed by the genlock's manufacturer, and put the A2320 into Active mode (flip the toggle switch on the back of the A2320 metal bracket to the left).

The A2320 will automatically provide you with a flicker-free high-resolution display of the Amiga's output. The genlock will function normally and provide the composite monitor or VCR connected to the genlock's video out connector with overlaid Amiga graphics and video as normal. If you experience any problems in obtaining a stable display, try a slight adjustment of the fine tuning control. If this does not help, please see the 'Troubleshooting' chapter in this manual.

If you cannot adjust the fine tuning control to produce a stable display with your external genlock installed and the information in the 'Troubleshooting' chapter does not correct the problem, then most likely your genlock is incompatible with the A2320. You can, however, continue to use your genlock with the A2320 board installed as you normally would; you will just not be able to use the video output from the A2320 to view your displays.

### **Software Compatibility —**

The A2320 Display Enhancer is compatible with, and transparent to, Amiga software packages. The A2320 is also compatible with all Amiga display modes, including hold-and-modify ("HAM") modes, Amiga overscan modes, and the new ECS modes, and fully supports the Amiga's 4096-color palette.

### **Monitor Compatibility —**

The A2320 Display Enhancer board's video output is compatible with standard multiscan (multisync) monitors (not "VGA-ONLY" monitors) and provides a standard DB15 VGA-style video output connector. A list of multiscan monitors that are compatible includes: Commodore's 1950 Multiscan Stereo monitor, NEC MultiSync® and MultiSync® II, Mitsubishi Diamond Scan™, Zenith ZCM 1490 (NTSC Amigas only), Taxan Multivision™ 770 Plus, AOC Multisync CM-314, and others. You may have to obtain an adapter cable from your local dealer that will allow your specific multiscan monitor to work with the standard DB15 VGA-style connector, or you may construct your own cable using the A2320 video pinouts as shown in Appendix B, matched to your specific monitor's identical input signals as shown in the user's manual supplied with your monitor.

### **Using the A2320 in NTSC and PAL Systems —**

The A2320 Display Enhancer board has been factory-adjusted to work with both NTSC and PAL Amiga systems and will automatically function correctly in both environments, providing that you have followed the adjustment procedure as described earlier. If you experience any problems, please see the following chapter, which will help you achieve the best possible display.

# 5.

## Troubleshooting

### General Troubleshooting —

If your Amiga does not boot up normally with the A2320 Display Enhancer installed, or if you are unable to produce a stable display, please do the following:

- 1) Make sure the monitor you are using is a multiscan VGA-compatible monitor and that your monitor cable is correctly installed and has the correct signal connections between your particular multiscan monitor and the standard 15-pin VGA connector on the A2320. Also check to be sure that your cables are screwed tightly into their connectors at both ends and that your monitor is set for the correct operational mode (i.e. analog RGB, etc.)
- 2) Make sure that all external peripherals are properly connected to the Amiga and that their cables are screwed tightly into their connectors.
- 3) Make sure that the mode switch on the back of the A2320's metal bracket is in the correct position for the fine tuning control adjustment. The mode switch should be flipped to the left (toward the fan). This is the Active mode.
- 4) Recheck your fine tuning control adjustment as described in Chapter 3. You may need to make sure that you have turned the fine tuning control completely through its range of fifteen full turns and slowly back again in order to correctly fine tune the A2320.
- 5) If the previous checks have not isolated the problem then make certain that the A2320 is installed correctly in the Amiga's video slot with the mounting screws securely attached to the back cover of the machine. You may need to remove the cover of the Amiga and re-install the A2320 board in the video slot and ensure that no internal cables have been dislodged and no other components or wires are contacting

the A2320 board itself. At this time, carefully make sure that the IC chips are firmly seated in their sockets on the A2320 board itself. Then re-install the A2320 board and confirm that it is properly seated.

- 6) If, after you have attempted to check for correct A2320 board installation and fine tuning control adjustment, you are still having problems, then your A2320 board may need to have its Coarse tuning control adjusted. Please see the section on 'Coarse and Fine Tuning Control Adjustment' later in this chapter. You may also need to perform the check in step 7.

If you are having problems obtaining a stable display when you have an external genlock connected to your Amiga, please try readjusting the fine tuning control and see if that fixes the problem. If the A2320 board was operating correctly before you connected your genlock to the system and adjusting the fine tuning control doesn't correct the problem, then turn off and unplug the Amiga, and proceed with the following check.

- 7) To insure that your computer was set properly at the factory, remove the Amiga's cover, as shown in the chapter on installing the A2320, and check to see that the shorting block on jumper J300 on the motherboard is on the default setting. This jumper is located under the power supply (noted in Fig. 2) but you may be able to see the jumper by looking back from the right front corner of the Amiga. The shorting block should be connecting the leftmost and center pins of the 3-pin jumper. This jumper determines the time base used for the 50/60 Hz CIA timer chip. In normal (factory default) position, the 50/60 Hz TICK clock, based on AC line frequency, is used as a time base. In the alternate position, the vertical sync pulse from the video section is used. The A2320 may not operate correctly if the vertical sync pulse is used as the CIA time base, with the jumper in the right-hand position.

## Coarse and Fine Tuning Control Adjustment —

If fine tuning efforts have not succeeded in stabilizing the display then you should perform the adjustment procedure described below.

### **WARNING!!!**

**The following procedure involves working within the case of the Amiga with the cover removed and the unit POWERED ON. High voltages are present inside the case. Severe injury to operator and damage to equipment could result from carelessness or ignorance in attempting to perform the adjustment.**

Turn OFF the Amiga and the monitor and remove the cover of the A2000 as described in the Installation chapter. Reconnect the mouse, keyboard, and multiscan monitor to the Amiga. Turn the machine so that the A2320 board can be seen in the A2000 video slot and locate the blue trimmer capacitor VC101 on the upper right section of the A2320 circuit board (see Fig. 4.) With the multiscan monitor still connected to the A2320 board and the A2320 Test/Demo disk in DF0:, power on both the Amiga and the monitor. (To minimize the likelihood of shock, be VERY careful not to touch or let anything touch the power supply or any components in the open Amiga case unless otherwise instructed.)

Below the trimmer capacitor VC101, locate the jumper block CN3. Move the black shorting block from the 'CLOSELOOP' position to the 'OPENLOOP' position. Insert the plastic alignment tool into the adjustment hole as before. Turn the fine tuning control clockwise twenty full turns, then counterclockwise seven full turns. This centers the tuning control adjustment to mid-range.

Now from the right side of the machine, turn the monitor so that the screen can be seen, and put the A2320 into Active mode using the mode switch (flip it to the left, toward the fan). Insert the plastic alignment tool into the top of the blue trimmer capacitor VC101 (twirl it a bit to engage the trimmer slot if necessary) and slowly turn the tool, observing the effects on the monitor. (Don't be afraid of turning too far; the trimmer just "wraps around" each full turn.)

Turn the trimmer slowly until the screen stabilizes, keeping in mind that this is a coarse adjustment. When the display is as stable as possible, remove the alignment tool from the trimmer. Move the shorting block on the CN3 jumper back to the 'CLOSELOOP' position and insert the plastic alignment tool into the fine tuning control hole in the metal bracket.

Now return to Chapter 3 and repeat the fine tuning procedure described there.

Finally, turn OFF both the Amiga and the monitor and remove the power cord. Re-install the A2000's cover and replace the five screws that were removed. Carefully re-install any removed equipment, peripherals, and finally the power cord. This completes the alignment of the A2320 Display Enhancer board for your Amiga setup.

**NOTE:** If you are still unable to properly adjust the A2320 and obtain a stable display with your specific Amiga/monitor setup, please contact your local Authorized Commodore service center.

## Appendix A: Theory of Operation

### Background Information —

In the world of Amiga video there are two primary modes of operation, *interlaced* and *non-interlaced*. The Amiga sends out video information in 'fields' of horizontal scan lines to make up a display on the monitor. In the interlaced mode, there are two fields, called even and odd, which when taken together make up a complete video frame. These fields are displaced from each other on the screen so that their respective scan lines are interleaved. In other words, the lines of the even field alternate vertically with the lines of the odd field. From top to bottom on the screen there is one line of the even field, then one line of the odd field, another line of the even field, etc., hence the term "interlace."

The video frame rate is 30 frames per second, so each field (half a frame) takes 1/60th of a second to be drawn on the screen—the standard Amiga hardware is not capable of sending out video data any faster than this. In the time that it takes for the electron beam to draw the second of the current interlaced frame's two separate fields, the first field has faded in brightness, since the glow of the phosphor dots the beam scans starts to dim as soon as the beam passes to the next pixel. When the refresh rate (how many times per second each field is redrawn) is too low—30 Hz or less—for the human eye to see as a single image, the perceived result is the annoying flicker of interlace mode. Non-interlace screens are essentially the SAME field scanned TWICE each frame, or sixty times per second, which is rapid enough to avoid the flicker.

With that background information we can now explain how the A2320 Display Enhancer board removes the flicker from the Amiga's interlaced display modes, and visible scan lines in non-interlaced display modes.

The A2320 Display Enhancer board is capable of operation in all Amiga graphics modes, to which it automatically adapts. In the non-interlaced graphics modes (i.e. 320 X 200/256 and 640 X 200/256) the A2320 Display Enhancer will automatically operate in Scan-

double mode. This means that the A2320 is repeating every line, at twice standard video rate, to increase the raster scan rate from 15.734 KHz NTSC (15.625 KHz PAL) to 31.46 KHz NTSC (31.25 KHz PAL). In this mode of operation, the A2320 removes visible scan lines from all images, fully supporting overscan and HAM displays, yielding a crisp and solid display. Another benefit of this mode of operation is that there are no motion artifacts, (i.e. shearing or ghosting effects) which has obvious value for animation and game software which has rapidly-moving objects.

In the interlaced Amiga modes (i.e. 320 X 400/512 and 640 X 400/512) the A2320 Display Enhancer automatically switches into De-interlace mode. This means that the A2320 is storing the previous video field and combining it with the current incoming video field at twice the video rate, to remove visible scan lines without adding flicker, while fully supporting overscan and HAM display modes. In this mode of operation you may notice some motion artifacts (i.e. a ghosting effect) with rapidly animated objects.

The A2320 has also been designed to be compatible with the new graphics modes available with the Enhanced Chip Set (ECS) under AmigaDOS 2.0.

The ECS 'Productivity Mode' has display of 640 X 480 pixels with 4 colors out of a palette of 64. In this display mode the A2320 will automatically bypass the video data to the multiscan monitor since the raster scan rate is already at 31.46 KHz and has no flicker or visible scan lines.

The ECS 'Superhires Mode' has a display of either 1280 X 200/256 or 1280 X 400/512 pixels with 4 colors out of a palette of 64, and a raster scan rate of 15.734 KHz NTSC (15.625 KHz PAL). In this display mode the A2320 only samples every other pixel and may cause a distorted display, so the board must be put into Bypass mode by setting the mode switch to the right.

## A2320 Display Enhancer Basic Building Blocks —

The major system blocks of the A2320 board are:

- 1) PLL (Phase Locked Loop) clock generator
- 2) 384K Field store and Line memories
- 3) Video controller gate array (AM8ER)
- 4) Hybrid D/A converter

### 1) PLL (Phase Locked Loop) clock generator

The PLL clock generator section consists of an NE564 PLL chip and is designed as a frequency multiplier with a user-adjustable phase control (the "fine tuning" control). In order to create a de-interlaced or scan-doubled image, two clocks that are related to the Amiga's system clock must be generated. These two clocks are 14.3 MHz (14.1 MHz PAL), and the main clock of 28.63 MHz (28.375 MHz PAL) for NTSC-based systems. Since the video slot only provides a 3.58 MHz (3.55 MHz PAL) clock, the frequency multiplier approach was used. The PLL circuit takes the available 3.58 MHz (3.55 MHz PAL) and creates the main clock of 28.63 MHz (28.375 MHz PAL) and, using a divider chain, generates the 14.3 MHz (14.1 MHz PAL) and 3.58 MHz (3.55 MHz PAL) clocks. The PLL then tracks the incoming 3.58 MHz with the divided-down 28.63 MHz clock so that the generated clocks now have a fixed relationship to the Amiga system clock.

Another problem that the PLL circuit must address is that the pixels coming from the Amiga's Denise chip at 14 MHz (or 28 MHz in ECS modes) do not have a constant phase relationship, across process variations, to the available 3.58 MHz clock. This problem requires the use of a phase circuit that must be user-adjusted so that the A2320's generated clocks correctly sample the incoming pixels from the Amiga, since individual machines vary slightly. The PLL circuit must also be able to handle two different clock frequencies. The NTSC and PAL Amigas' main clock frequencies of 28.636 MHz/28.37516 MHz (less than a 1% difference) require the use of a trimmer capacitor (coarse adjustment control) to set a median frequency which is close enough so that regardless of which system the A2320 is in, the PLL can function correctly.

## 2) 384K Field Store and Line memories

The A2320 uses three 1-MBit CMOS Frame memories to store a field of 12-bit-wide pixels. The frame memories allow simultaneous read/write action in such a manner that as one new 12-bit-wide pixel is being written, the previous field's 12-bit-wide pixel, at the same line/field location, is being read. The AMBER gate array controls the reading and writing of the frame memories so that this action happens properly. The other major element of the A2320 memory section is the line memories. The line memories are used to double the pixel rate of the incoming video data, as well as for the field-delayed data from the frame memories. The output of each pair of line memories (two for the current line data and two for the field-delayed data) is sent to the gate array controller for multiplexing and reclocking of the video data.

## 3) Video controller gate array (AMBER)

The heart of the A2320 Display Enhancer system is the AMBER gate array chip. This chip provides synchronization and control signals for the correct operation of the frame memories and line memories, as well as the proper horizontal and vertical sync signals that control the multiscan monitor. The AMBER chip also controls the pixel data path so that the correct line (i.e. current or delayed) is sent to the D/A converter, depending on the operational mode (i.e. De-interlace or Scan-double mode). The AMBER chip must also detect whether the A2320 is operating in a PAL or NTSC Amiga system and whether or not there is an external genlock in the system, to adjust the A2320 control functions accordingly.

## 4) Hybrid D/A converter

The de-interlaced/scan-doubled 12-bit-wide digital RGB data coming from the AMBER gate array must be converted to analog RGB for the multiscan monitor to display the image. A custom hybrid digital-to-analog converter using a simple, laser-trimmed weighted resistor network is employed for this conversion process. This D/A converter is capable of directly driving a 75-ohm load.

# Appendix B: Technical Specifications

- 1) Horizontal Frequency:  
NTSC—31.468 KHz unbypassed, 15.734 KHz bypassed  
PAL—31.25 KHz unbypassed, 15.625 KHz bypassed
  - 2) Vertical Frequency:  
NTSC—60 Hz  
PAL—50 Hz
  - 3) Video Signal outputs: Analog, 0.7 Vp-p/75 ohm, positive polarity.
  - 4) Video Sync Signals: Separate, TTL level, negative polarity.
  - 5) Pixel output:  
NTSC—35nS wide, 910 pixels/line output with B02 active  
PAL—35nS wide, 90B pixels/line output with 802 active
  - 6) Horizontal Sync Pulse:  
NTSC—2.4μS wide, active low, TTL level  
PAL—2.4μS wide, active low, TTL level
  - 7) Vertical Sync Pulse:  
NTSC—190μS wide, active low, TTL level  
PAL—160μS wide, active low, TTL level
  - B) Overscan support:  
NTSC—768 X 4B9 worst case  
PAL—768 X 576 worst case
- Note:** Certain software packages may use overscan this severe, however the operating system nominally does not perform to this level.
- 9) Connector: DB15 female VGA-style connector and pinout.
  - 10) Monitors supported: Most multiscan VGA monitors such as Commodore 1950, NEC MultiSync® and MultiSync® II, Mitsubishi Diamond Scan™, Zenith ZCM 1490 (NTSC Amigas only), Taxan Multivision™ 770 Plus, AOC Multisync CM-314, and others.



11) FCC Approval: FCC Class B approved.

12) Power Consumption: +5VDC  $\pm$  5%, 3 Watts.

13) Video Bandwidth: 30 MHz @ -3dB.

**A2320 DB15 Video pinout:**

Output Connector: DB15 female VGA-style connector.

Pin 1: Analog Red

Pin 2: Analog Green

Pin 3: Analog Blue

Pin 4-8: Ground

Pin 9: No Connect

Pin 10-12: Ground

Pin 13: N—Hsync

Pin 14: N—Vsync

Pin 15: No Connect